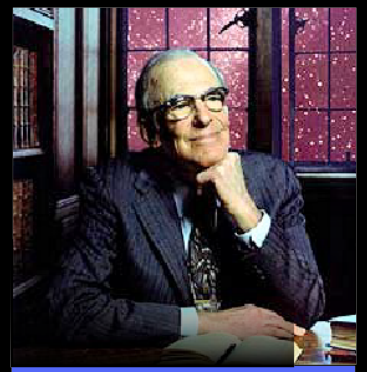
HUBBLE SPACE TELESCOPE 30

# HUBBLE SPACE TELESCOPE

*30 Years of Discovery*

# FROM IDEA TO LAUNCH

## 1940



**1946**

Spitzer's famous paper

## 1950

**1958**

NASA is established

## 1960

**1962**

National Academy of Sciences recommends a large space telescope to be a US national priority

## 1970

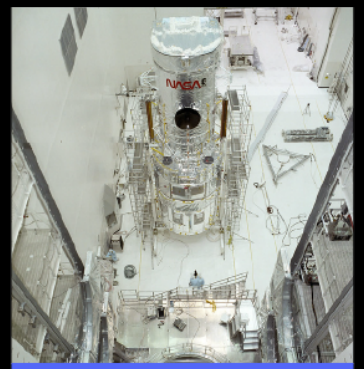
**1977**

US Congress funds the "Large Space Telescope Project"

**1976**

Combined proposal

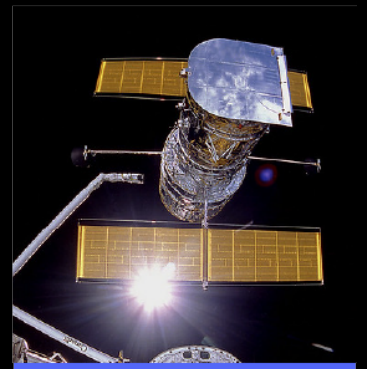
## 1980



**1985**

Hubble is Complete

## 1990



**1990**

Hubble is launched and deployed

**LAUNCH DATE**
April 24, 1990

**LAUNCH VEHICLE**
Space Shuttle Discovery (STS-31)

**MASS**
Approximately 12,000 kilograms
as of Servicing Mission 4

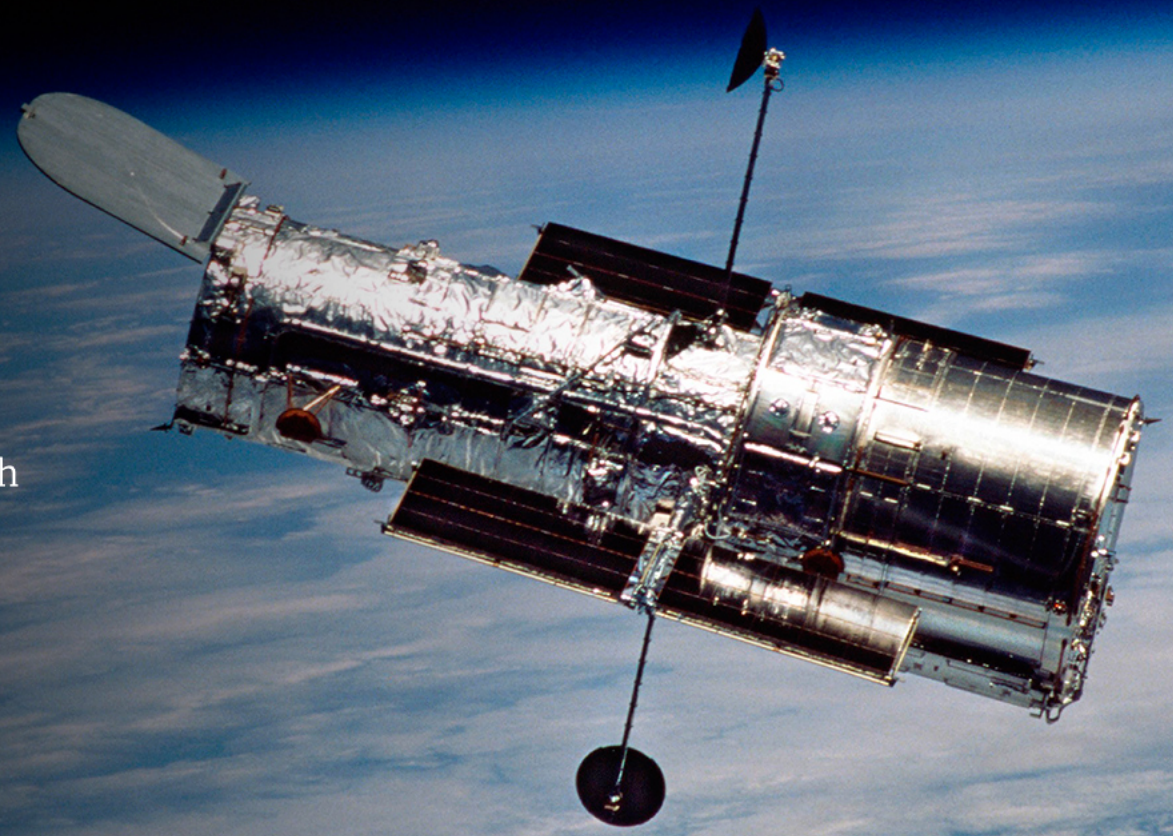
**MAXIMUM DIAMETER**
14 ft (4.2 m)

**LENGTH**
43 ft (13 m)

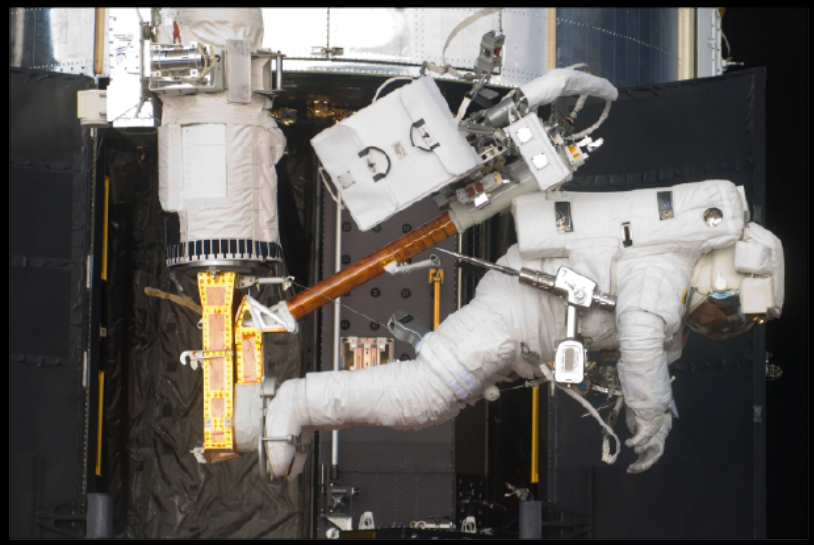
**ORBIT HEIGHT**
About 340 miles (540 kilometers) above the Earth

**ORBIT PERIOD**
Approximately 95 minutes to complete
one orbit around Earth

**ORBIT VELOCITY**
About 17,000 mph (27,300 kph)

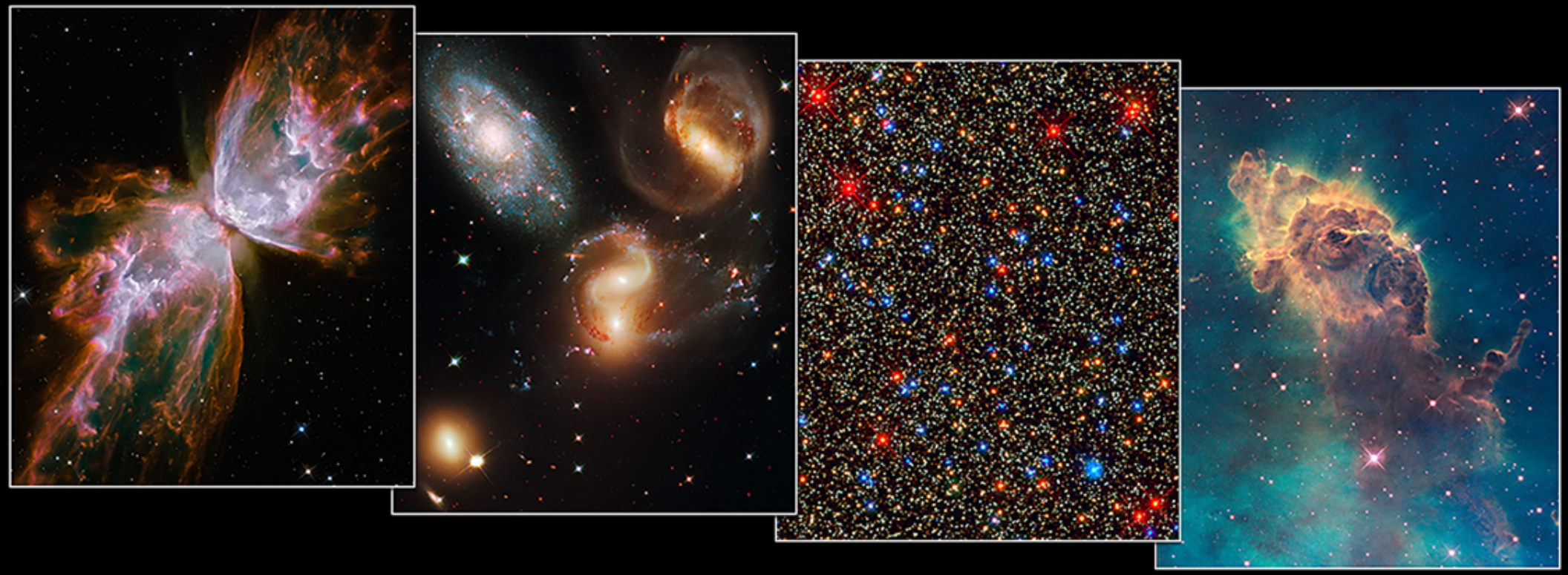


# SERVICING MISSION 4

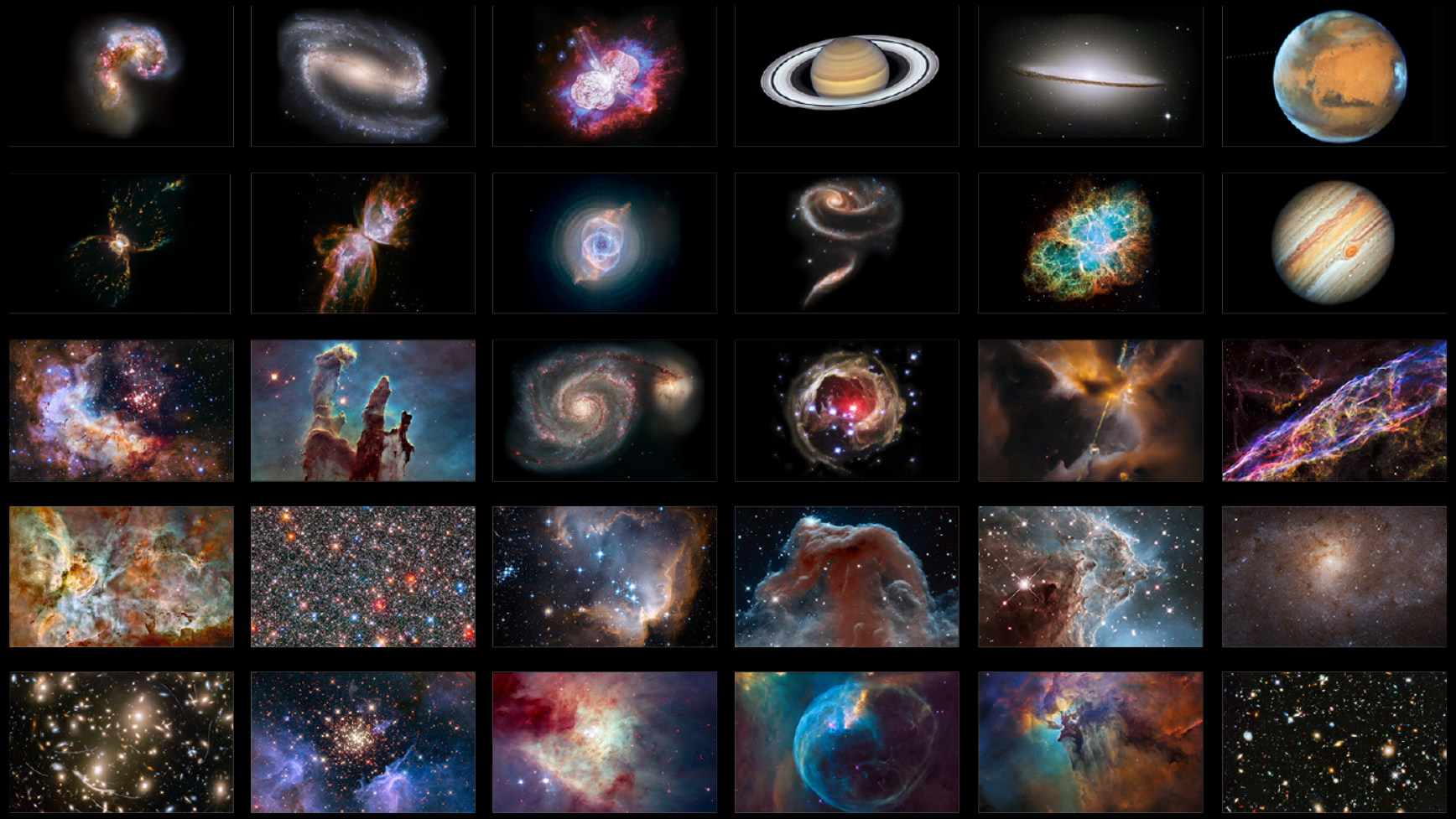


# SERVICING MISSION 4

## Early Release Observations



# As Hubble looks into the distance, it looks back in time.



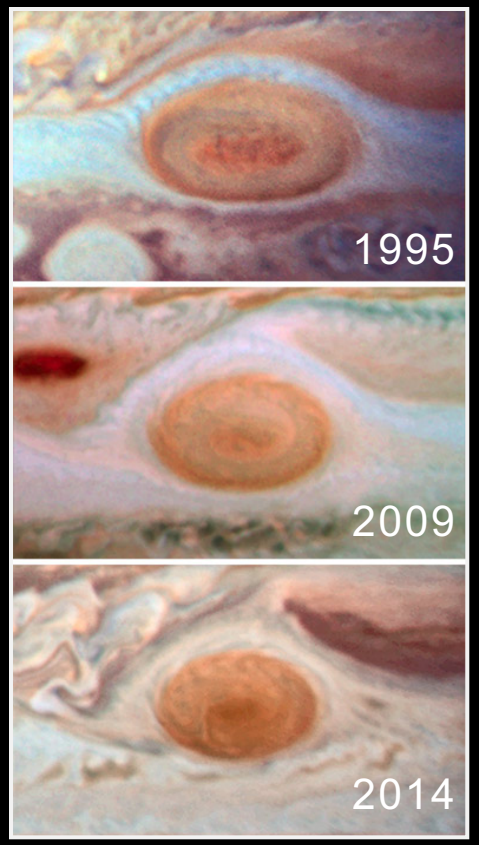
**Planets**
Minutes to hours

**Stars**
Years to thousands of years

**Galaxies**
Millions to billions of years

**Universe**
Billions of years

# JUPITER: THE SHRINKING RED DOT




**Planets**
Minutes to hours

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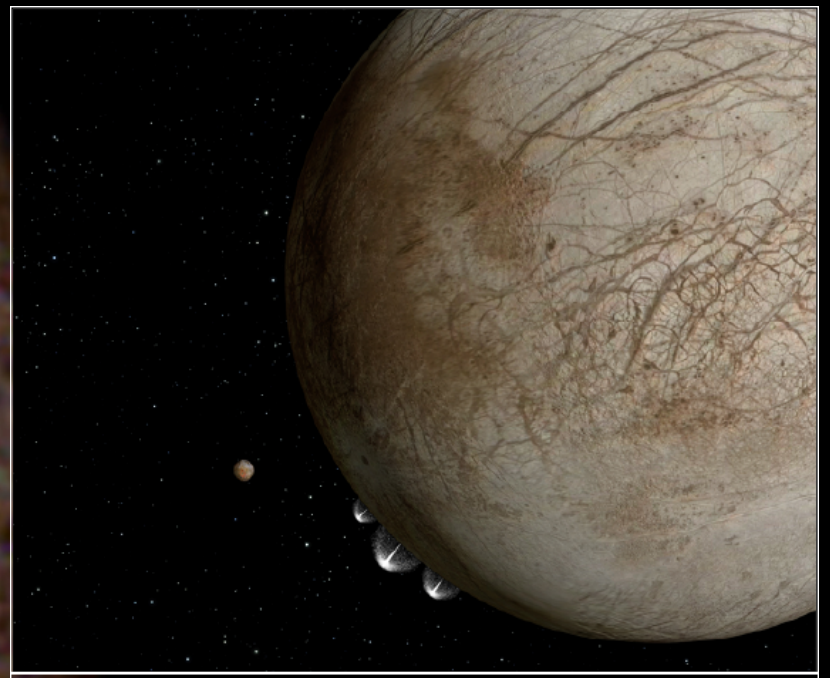
# EUROPA: WATER?



**ARTIST'S CONCEPT**
*Water-ice plumes erupting*

**Planets**
Minutes to hours

**Stars**
Years to thousands of years

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Millions to billions of years

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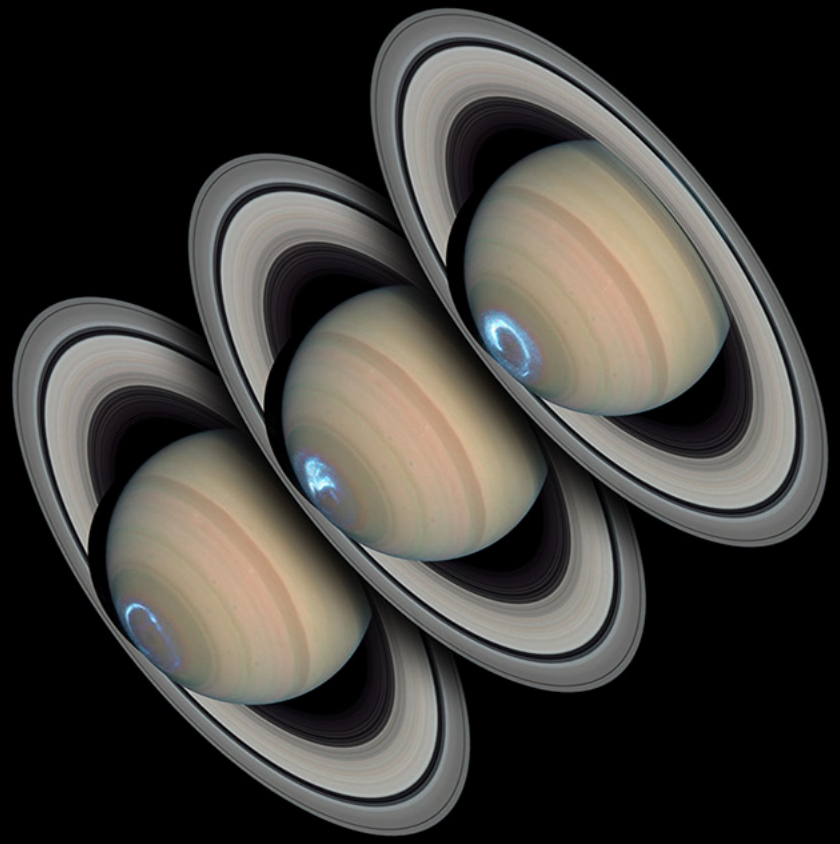
Billions of years

# JUPITER AURORA

# SATURN AURORA



**Planets**
Minutes to hours

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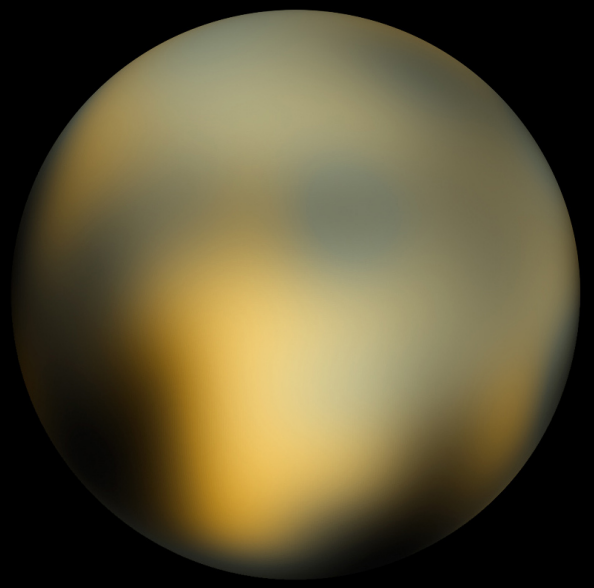
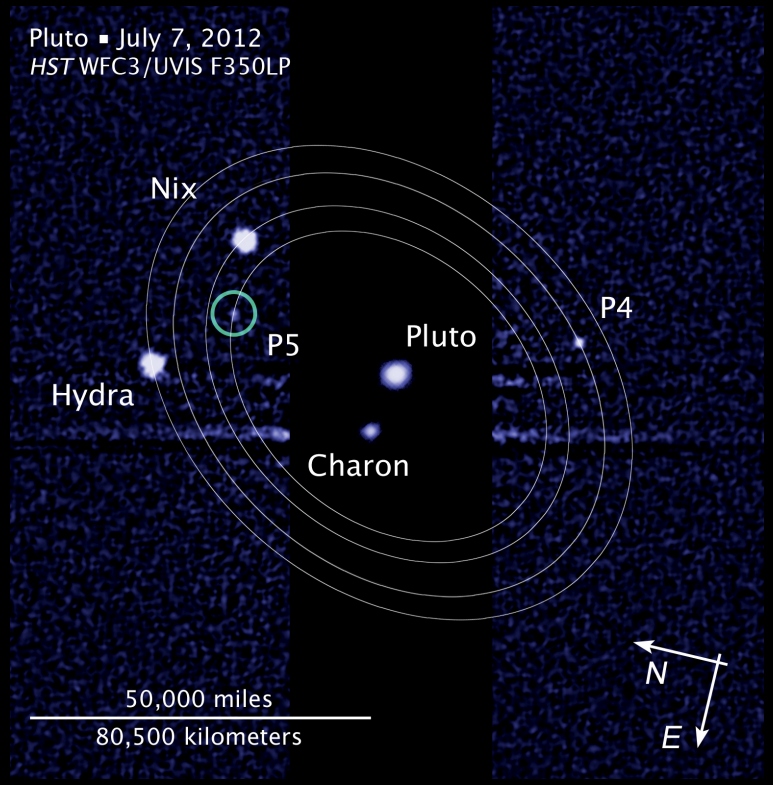
# PLUTO



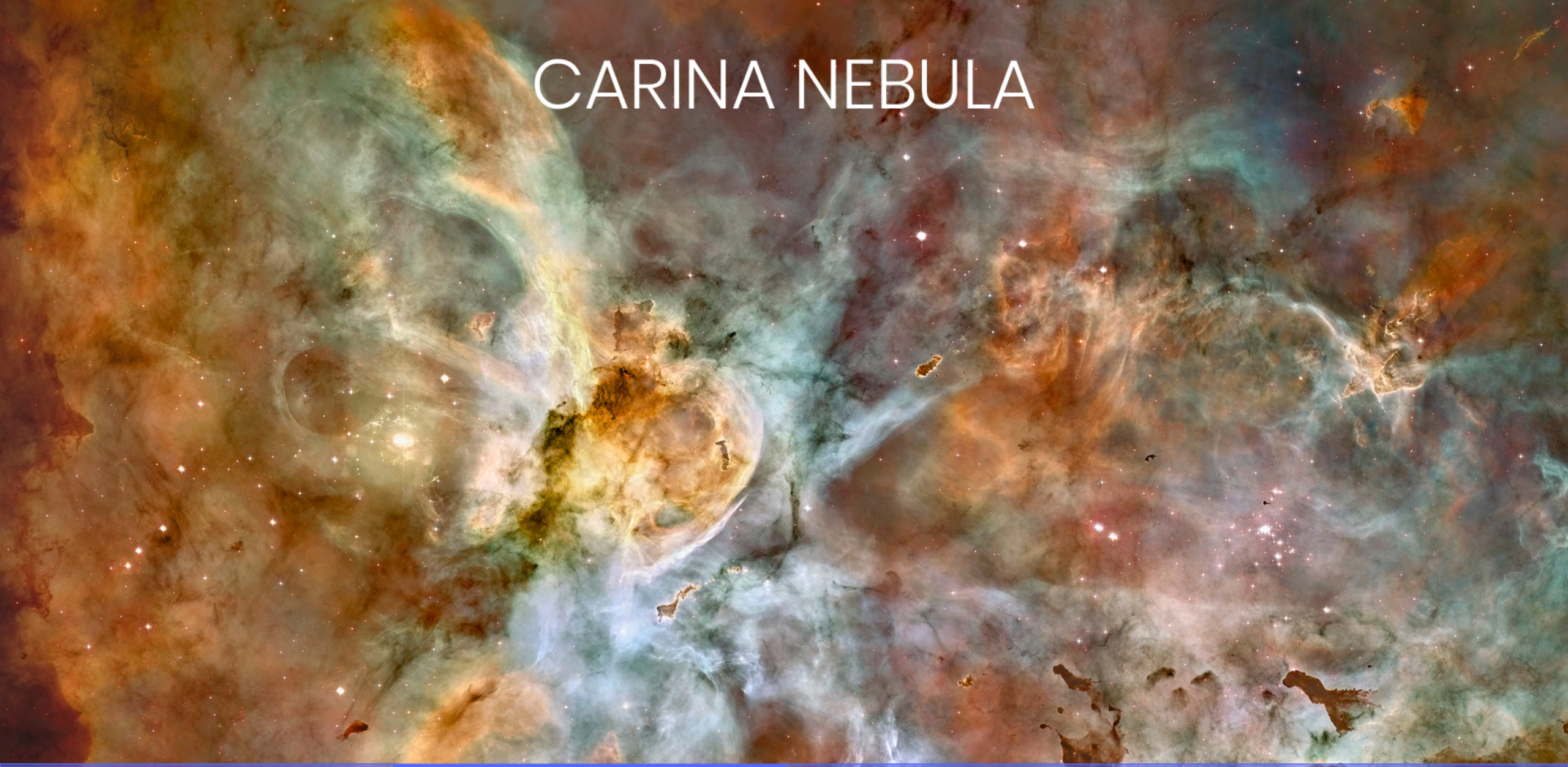
180°

2010 HST observations



2015 New Horizons observations

| **Planets** | **Stars** | **Galaxies** | **Universe** |
|---|---|---|---|
| Minutes to hours | Years to thousands of years | Millions to billions of years | Billions of years |




**Planets**
Minutes to hours

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Years to thousands of years

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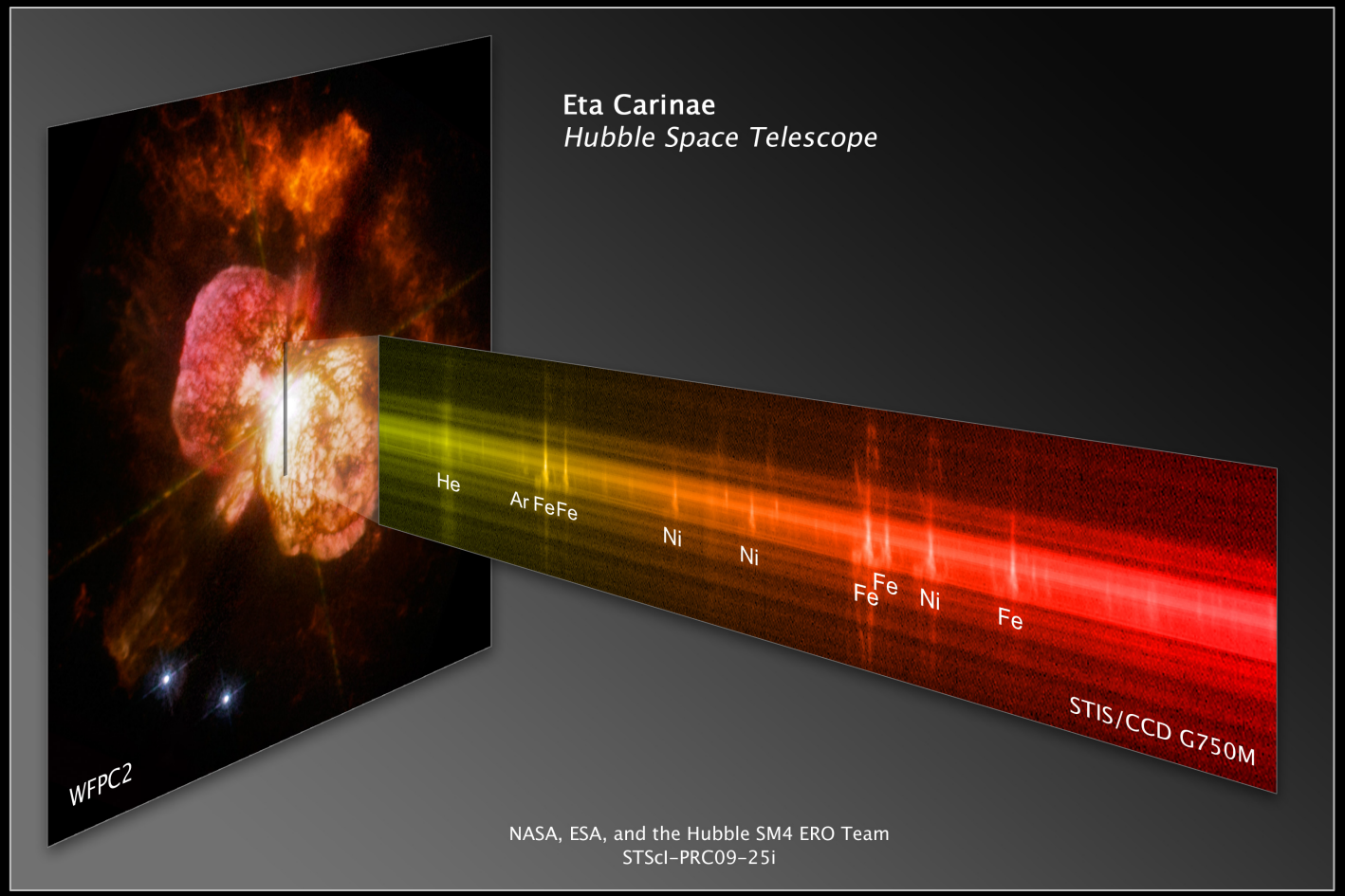
# ETA CARINAE




**Planets**
Minutes to hours

**Stars**
Years to thousands of years

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Millions to billions of years

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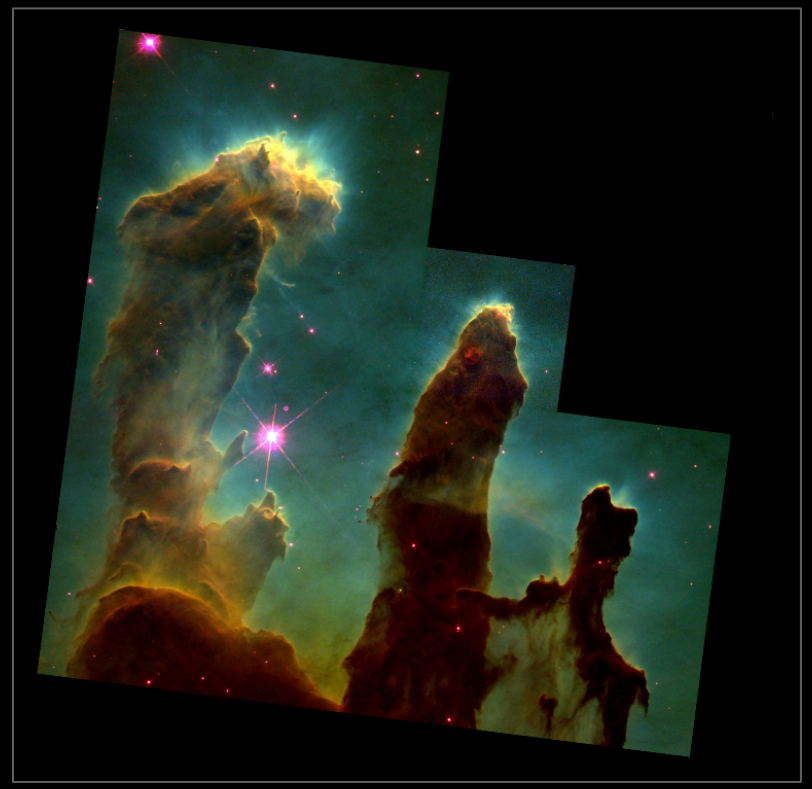
Billions of years

# M16 PILLARS OF CREATION



M16 PILLARS OF CREATION
OPTICAL / 1995

M16 PILLARS OF CREATION
OPTICAL / 2015

M16 PILLARS OF CREATION
NEAR INFRARED / 2015

**Planets**
Minutes to hours

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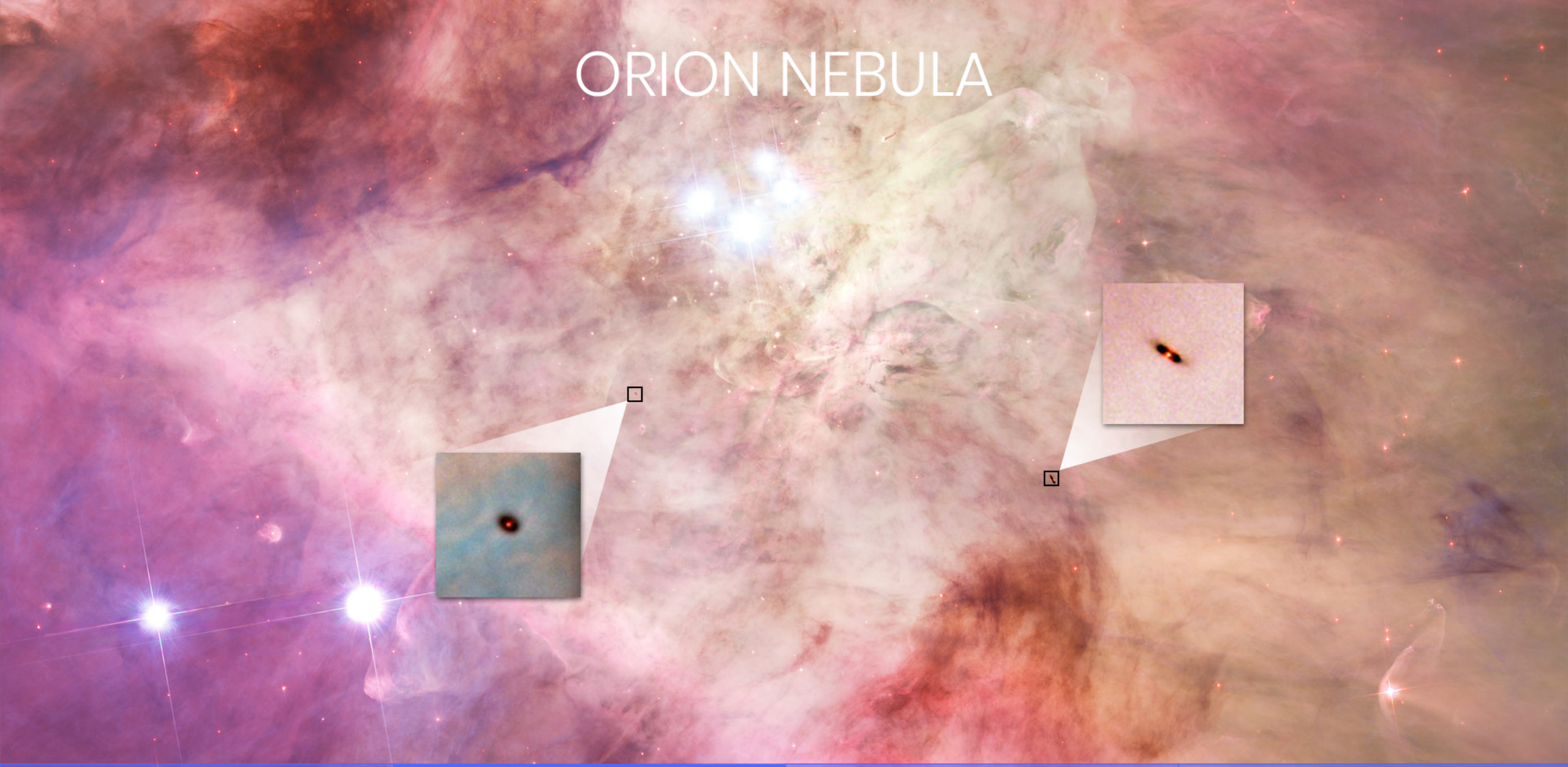


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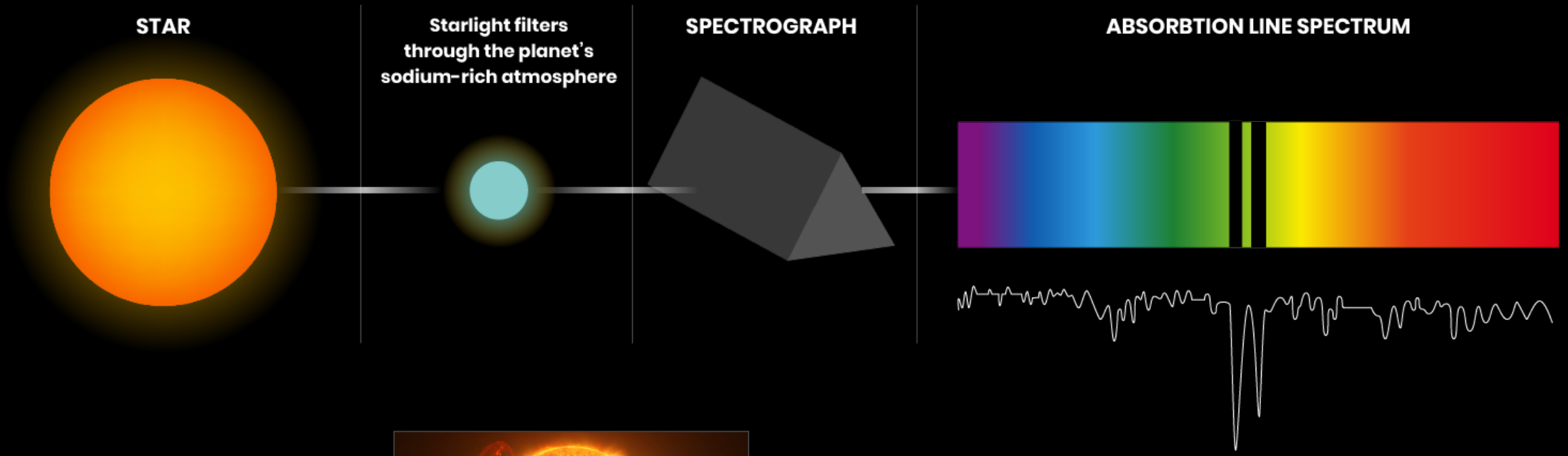
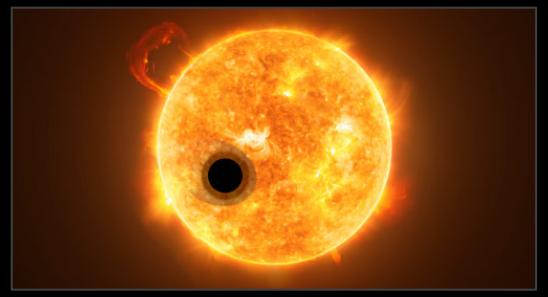
# EXOPLANET ATMOSPHERES



**HD 209458B**

*First detections of sodium, hydrogen, oxygen, and carbon in an exoplanet atmosphere*

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|---|---|---|---|
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# CAT'S EYE NEBULA

| Planets | Stars | Galaxies | Universe |
| --- | --- | --- | --- |
| Minutes to hours | Years to thousands of years | Millions to billions of years | Billions of years |

**Planets**
Minutes to hours

**Stars**
Years to thousands of years

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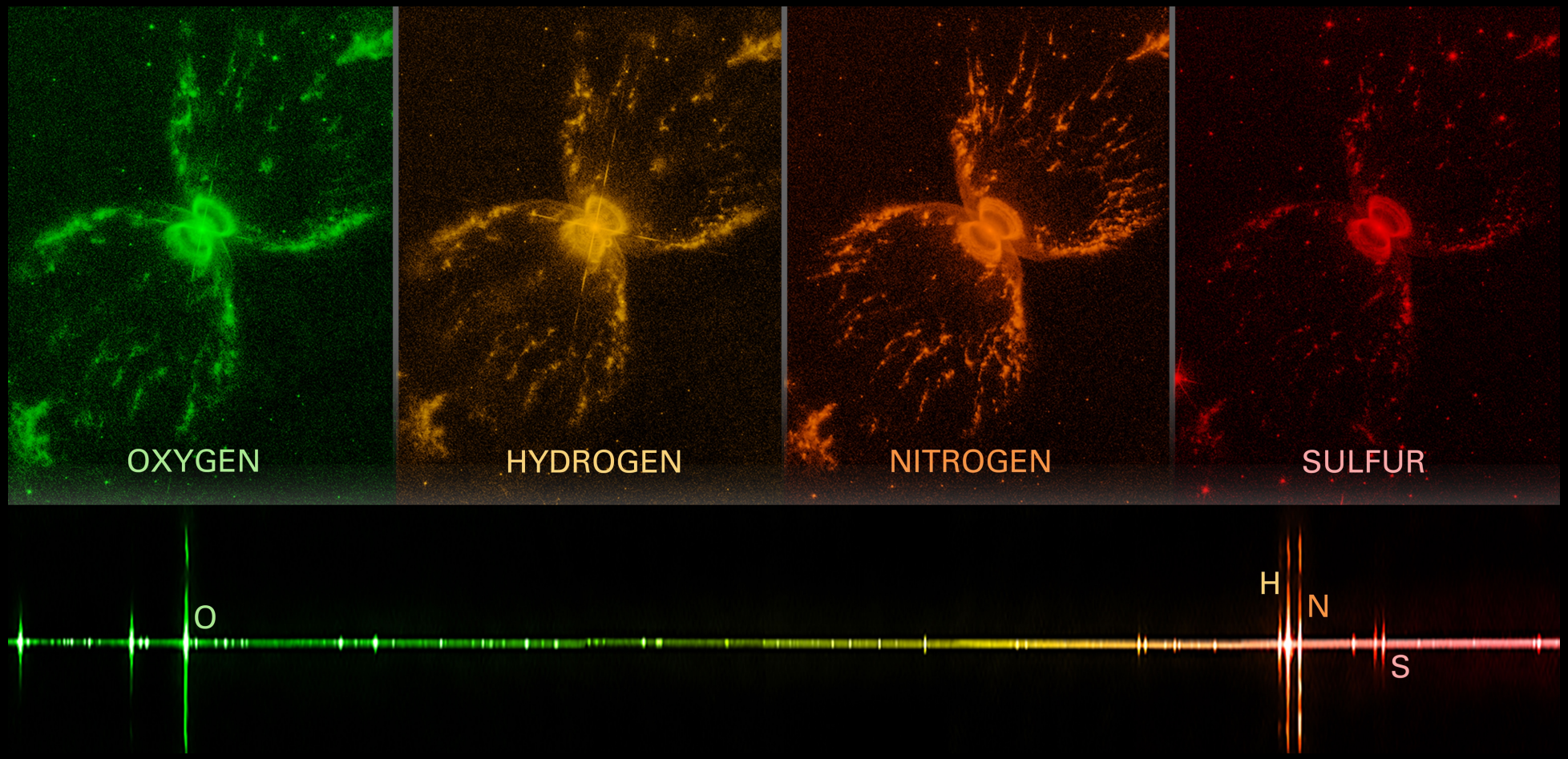
# SOUTHERN CRAB NEBULA




**Planets**
Minutes to hours

**Stars**
Years to thousands of years

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Millions to billions of years

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Billions of years

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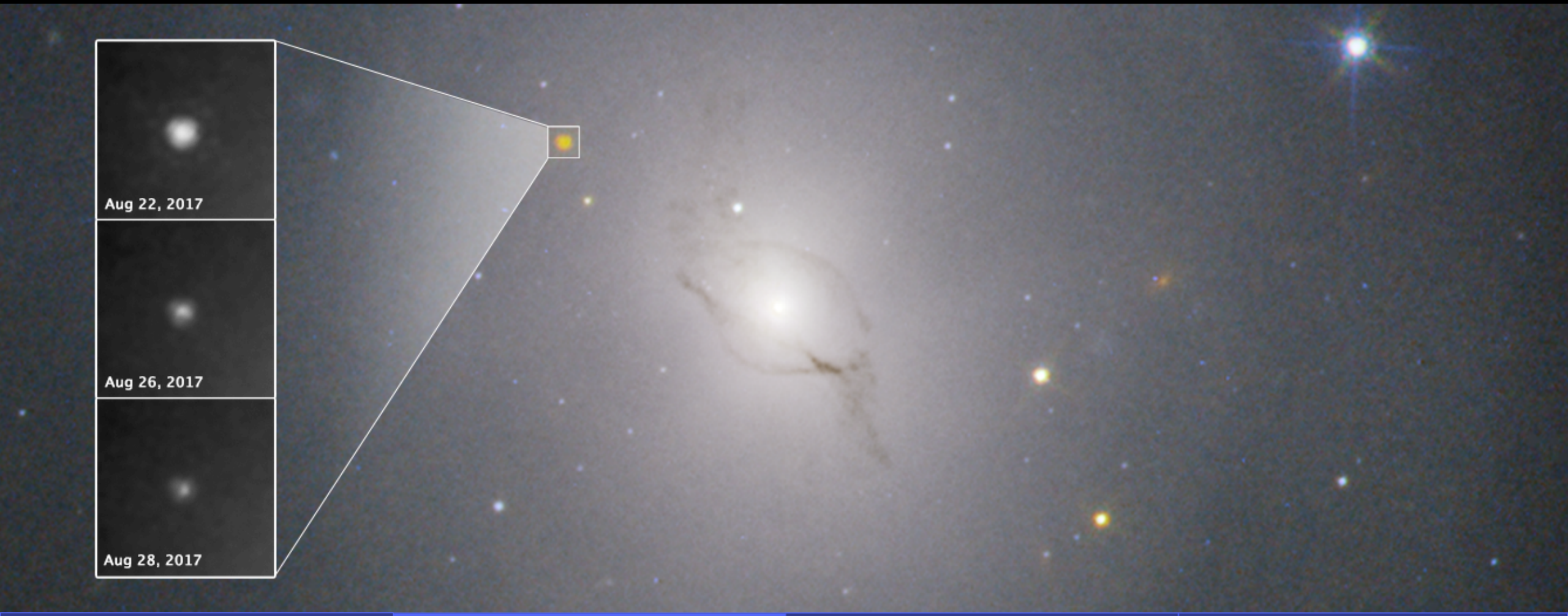
# NEUTRON STAR MERGER

## Multi-Messenger Astronomy




**Planets**
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Years to thousands of years

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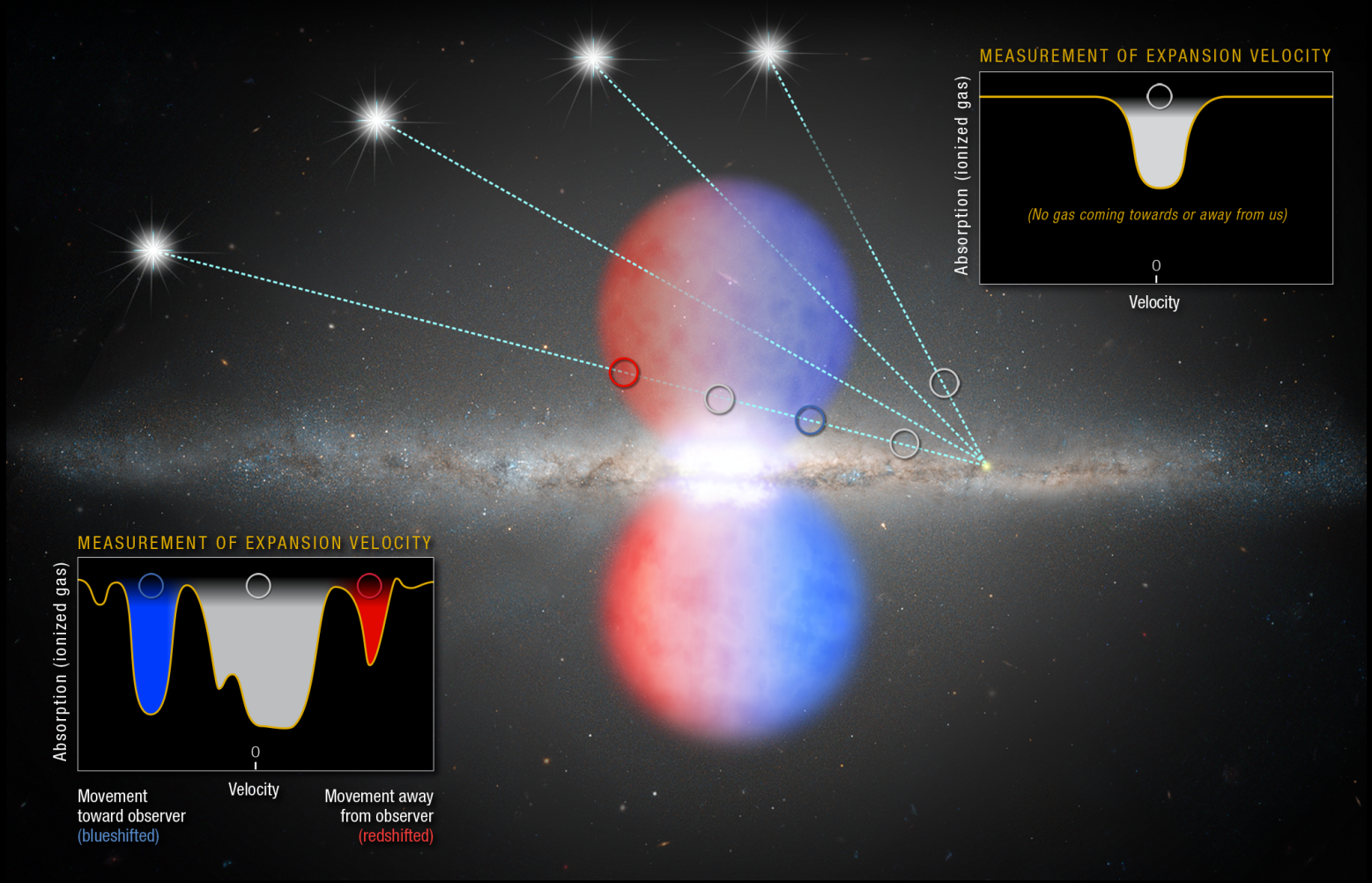
# FERMI BUBBLES: MILKY WAY




**Planets**
Minutes to hours

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Years to thousands of years

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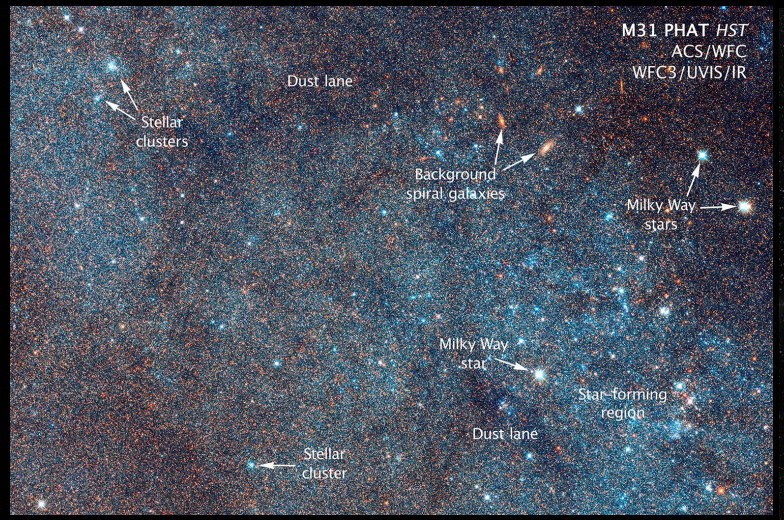
# ANDROMEDA: M31



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# RUBIN'S GALAXY

**Planets**
Minutes to hours

**Stars**
Years to thousands of years

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Millions to billions of years

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Billions of years

# THE ANTENNAE

**Planets**
Minutes to hours

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# ROSE GALAXY

**Planets**
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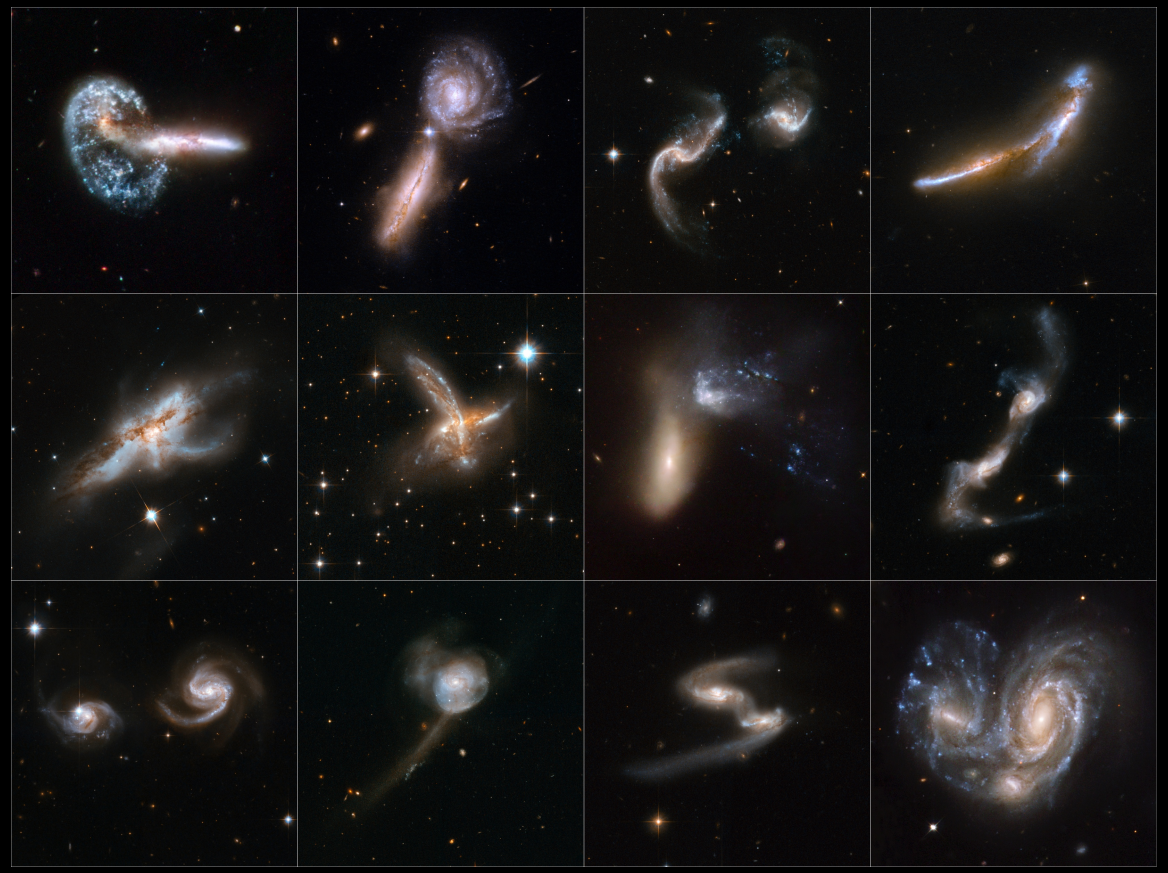
# GALAXY COLLISIONS



| Planets | Stars | Galaxies | Universe |
| --- | --- | --- | --- |
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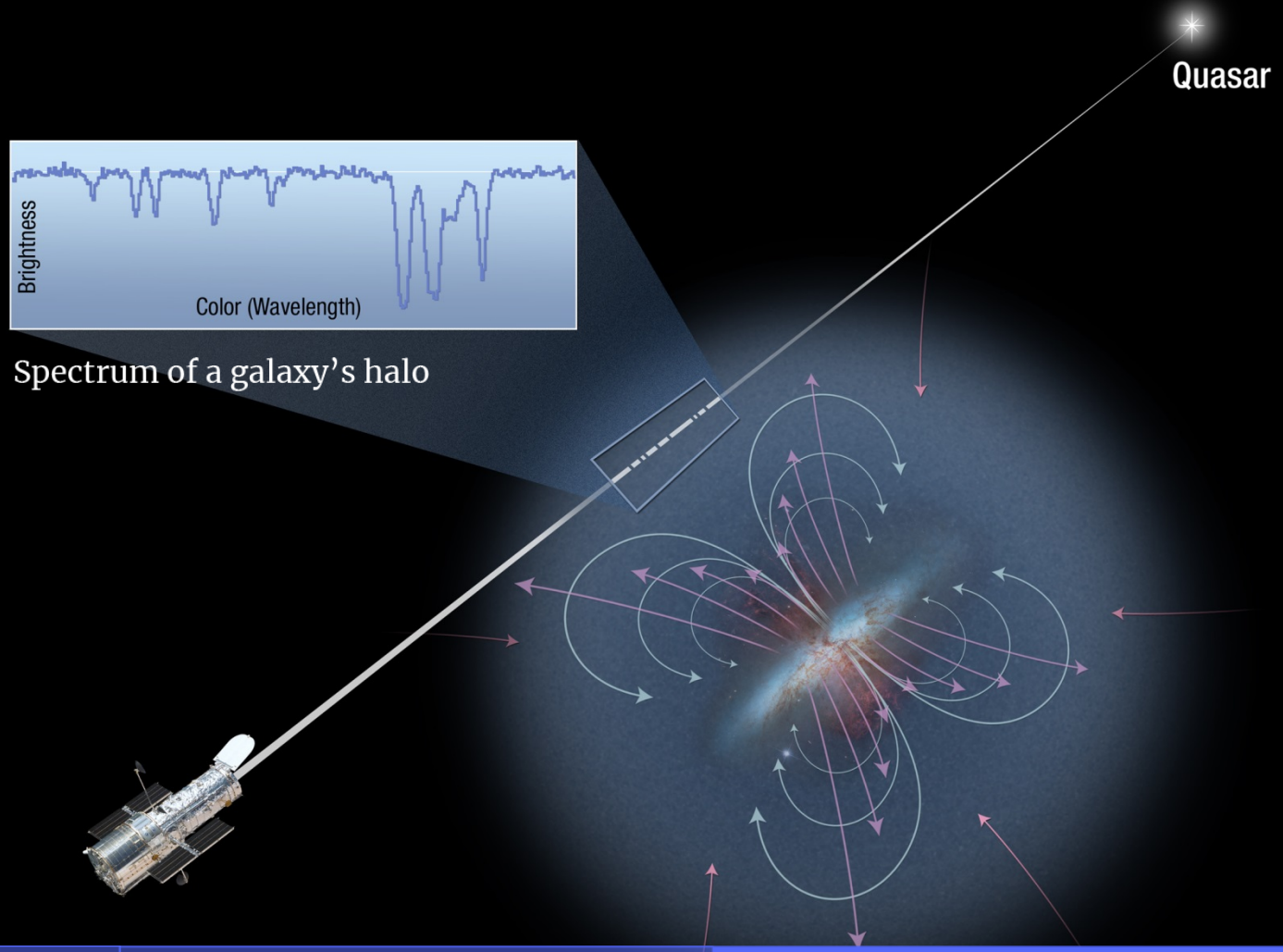
# GALACTIC RECYCLING




**Planets**
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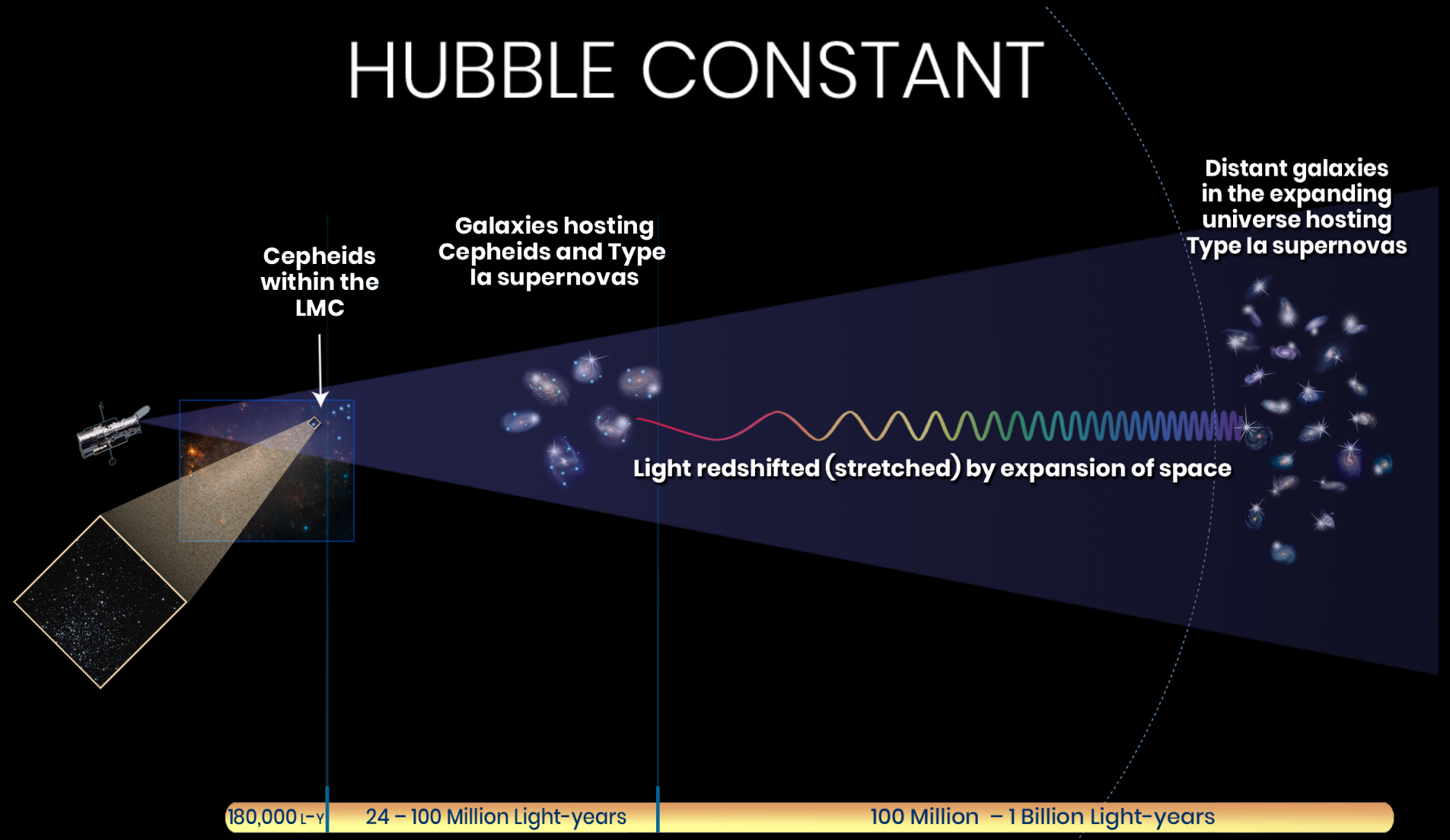
# HUBBLE CONSTANT




| Planets | Stars | Galaxies | Universe |
|---|---|---|---|
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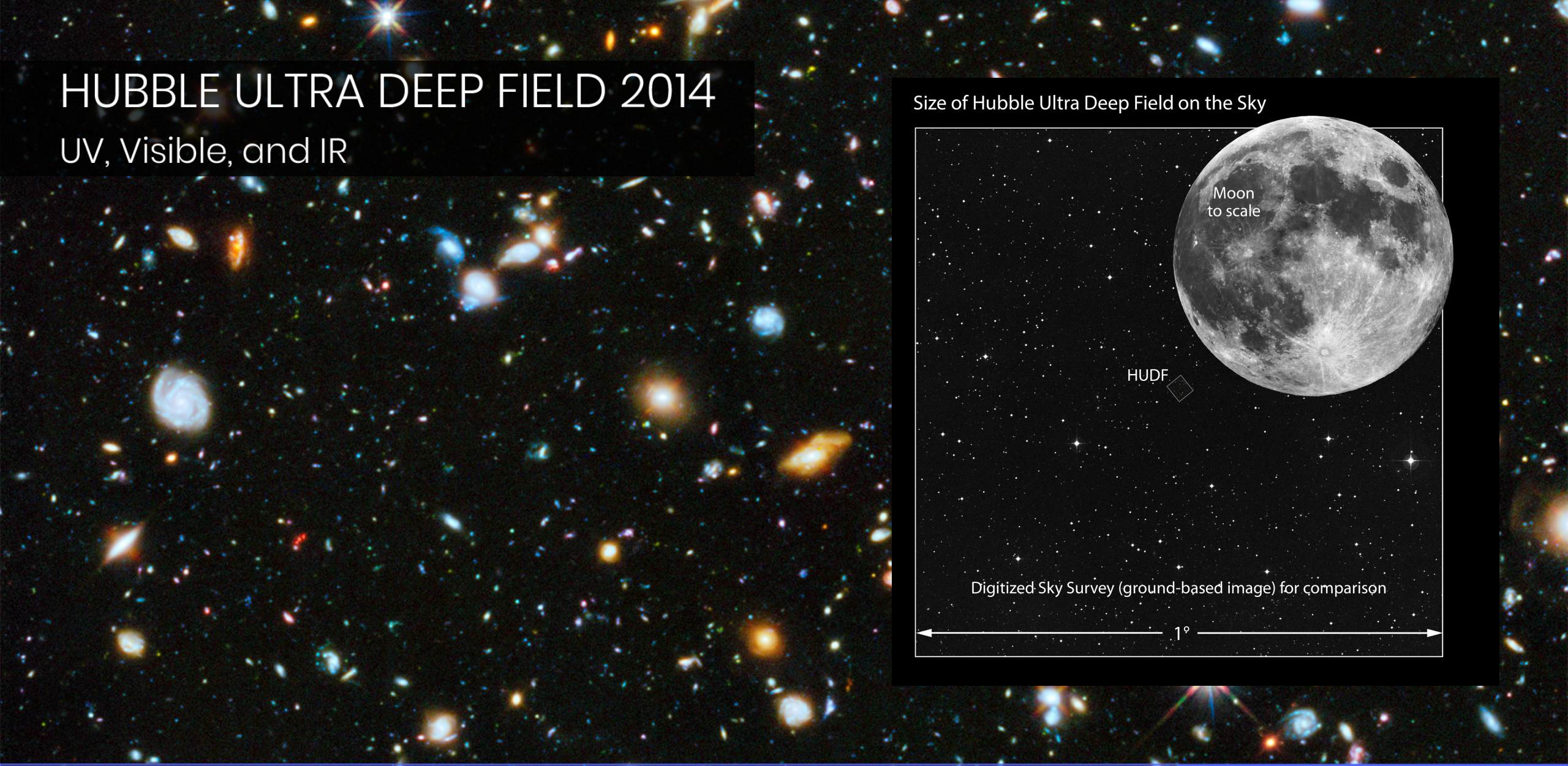
# HUBBLE ULTRA DEEP FIELD 2014

## UV, Visible, and IR






**Planets**
Minutes to hours

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ABELL 370
Planets
Minutes to hours
Stars
Years to thousands of years
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# HUBBLE DISCOVERIES

## ORIGINAL SCIENCE GOALS

The Cosmic Scale and Hubble Constant

Gas Inside and Outside Galaxies

Brightness of Supernovae

Origin and Evolution of the Solar System

Supermassive Black Holes

## ADDITIONAL SCIENCE EXAMPLES

Source of Gamma Ray Bursts

Dark Energy and the Universe's Expansion

Ages of Stars Beyond the Milky Way

Gravitational Lensing and Dark Matter

Star Formation History of the Early Universe

Imaging and Atmospheric Analysis of Exoplanets

Star and Planetary System Formation

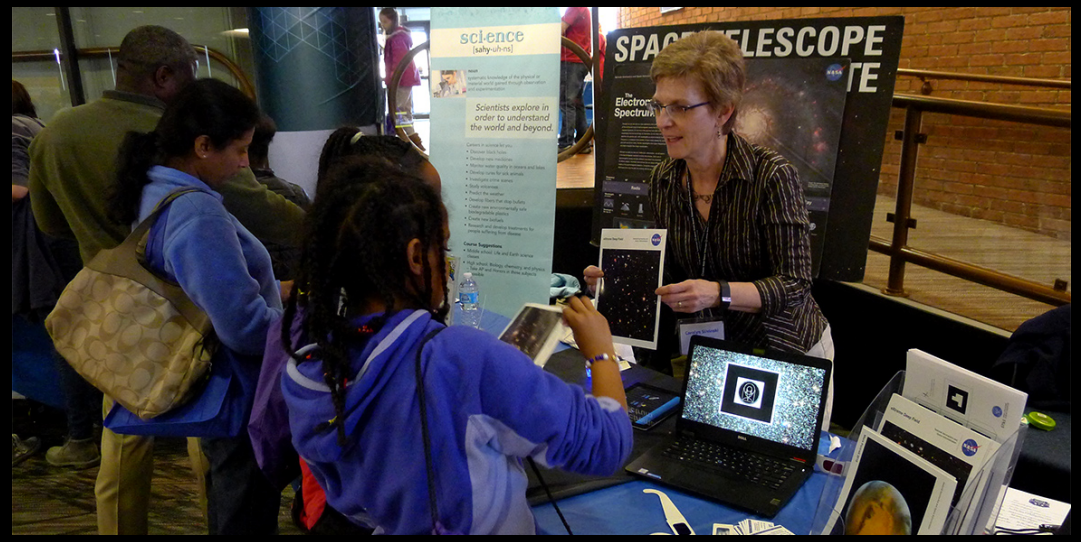
Multi-Messenger Astronomy

Barbara A.

MIKULSKI ARCHIVE FOR SPACE TELESCOPES

# HUBBLE OUTREACH

## Broadening the public's understanding of cutting-edge astronomical missions and research



- Communicating the latest astronomical findings and discoveries to the public
- Engaging Youth in Their Communities
- Engaging audiences historically underserved

- Exhibiting at Large-scale and local public events
- Leveraging strategic partnerships
- Connecting Art and Science

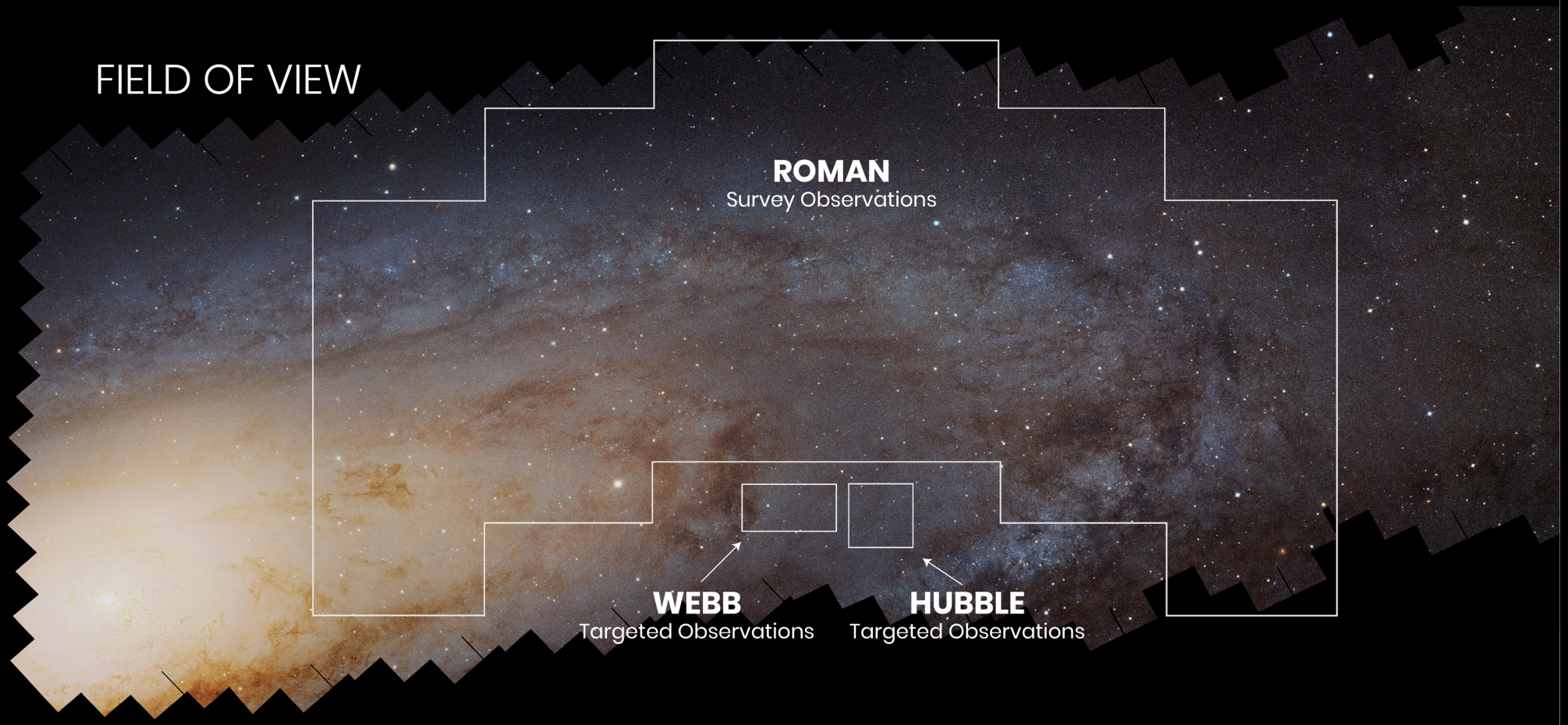
## MIRRORS

HUBBLE

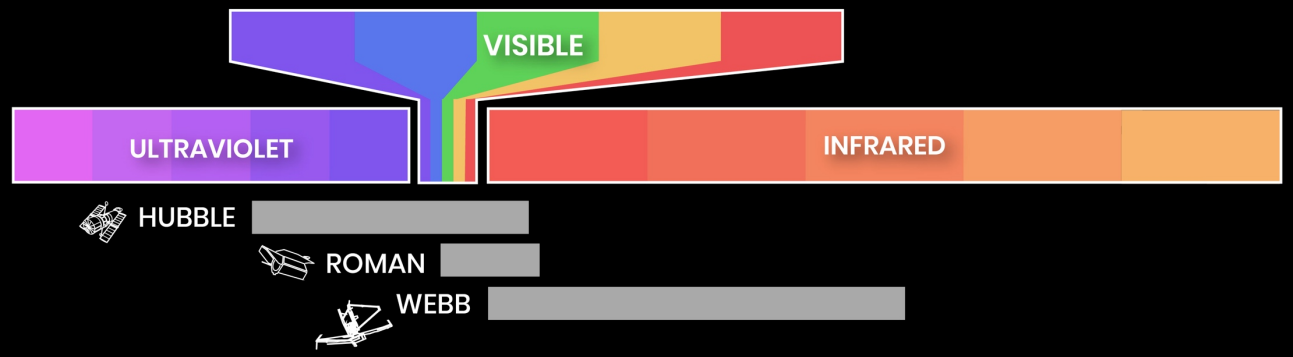
ROMAN

WEBB

## FIELD OF VIEW




## WAVELENGTH



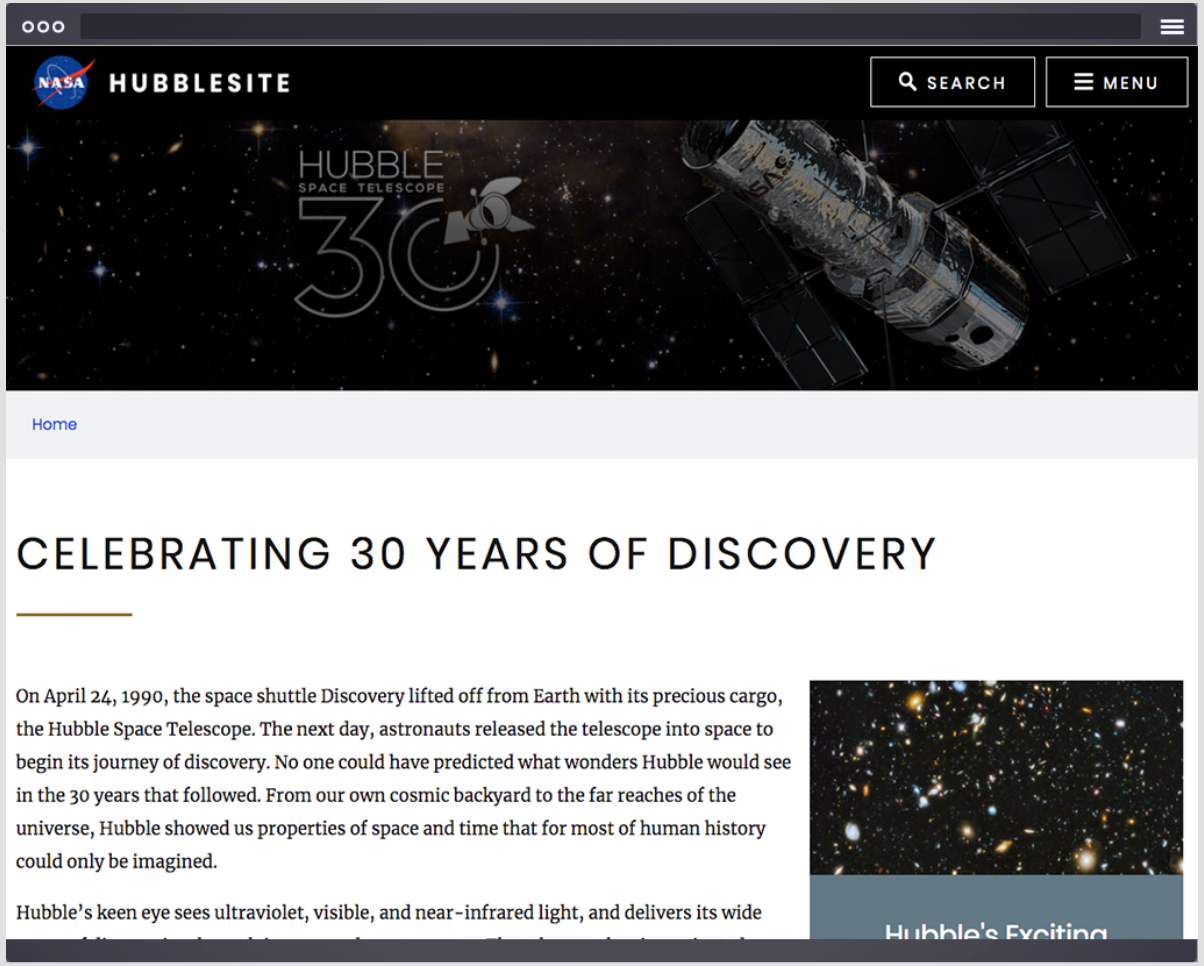
# HUBBLE 2020 VISION

**Continued operation well into the 2020s**

- Robust operations until at least 2025
- Most productive observatory
- Ultraviolet Legacy Library of Young Stars as
- Essential Standards (ULLYSES)
- Strong science synergies with James Webb Space Telescope to enable new science

**Key Science Threads**

- Characteristics of exoplanetary atmospheres
- Probing evolution across the universe
- Exploring traces of dark energy
- Probing the effect of dark matter
- Properties of black holes on all scales
- Tracing the distributions of chemical of life in the universe
- Investigating phenomena and sites for possible exploration




https://hubblesite.org/30